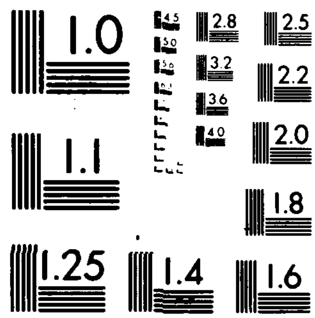
AD-A086 241 NATIONAL AVIATION FACILITIES EXPERIMENTAL CENTER ATL--ETC F/G 1/2
ACTIVE BEACON COLLISION AVOIDANCE SYSTEM TEST BED FOR THE 1978 --ETC(U)
MAY 80 M COHEN, C RICHARDSON

UNCLASSIFIED FAA-NA-79-12 NL

END
DATE
FILMED
8 80
DTIC



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS 1963 A

Report No. FAA-NA-79-12 SU

(14)

(12) LEVEL II

(6) ACTIVE BEACON COLLISION AVOIDANCE SYSTEM TEST BED FOR THE 1978 LOS ANGELES FLIGHTS,

(9) Rept. for Jul 76- Aug 78,

(10) Maurice/Cohen
Charles/Richardson

NAFEC REPORT

(11) MAY 1980 (12) 17

Document is available to the U.S. public through the National Technical Information Service, Springfield, Virginia 22161.

Prepared for

U. S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION
National Aviation Facilities Experimental Center
Atlantic City, New Jersey 08405

240550

NOTICE

The United States Government does not endorse products or manufacturers. Trade or manufacturer's names appear herein solely because they are considered essential to the object of this report.

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
FAA-NA-79-12	AD-A086241	

4. Title and Subtitle	5. Report Date
ACTIVE BEACON COLLISION AVOIDANCE SYSTEM TEST BED FOR THE 1978 LOS ANGELES FLIGHTS	May 1980
	6. Performing Organization Code
7. Author(s)	8. Performing Organization Report No.
Maurice Cohen and Charles Richardson	FAA-NA-79-12
9. Performing Organization Name and Address	10. Work Unit No. (TRAIS)
Federal Aviation Administration National Aviation Facilities Experimental Center Atlantic City, New Jersey 08405	11. Contract or Grant No. 052-241-250
	13. Type of Report and Period Covered
12. Sponsoring Agency Name and Address	NAFEC July 1976 - August 1978
Federal Aviation Administration National Aviation Facilities Experimental Center Atlantic City, New Jersey 08405	14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

This document describes the test bed configuration of the Federal Aviation Administration (FAA)/air traffic control radar beacon system/Discrete Address Beacon System (ATCRBS/DABS) active mode beacon collision avoidance System (BCAS). BCAS is a ground-independent, air-to-air system activated by eliciting replies from surrounding altitude-reporting transponders within a 32-nautical mile radius. The BCAS provides a positive climb or dive command to the pilot 30 seconds prior to any possible collision. The BCAS also advises the pilot of all aircraft with marginally safe separation. Feasibility flight tests of the test bed configuration were conducted at the National Aviation Facilities Experimental Center (NAFEC), Atlantic City, N.J., Washington, D.C., and Los Angeles, California, from 1976 through 1978. The test bed included the multilevel power interrogation capability referred to as "whisper-shout," intended to segregate responding aircraft transponders to distribute the computer processing workload and reduce garble.

17. Key Words	18. Distribution Statement
Beacon Collision Avoidance BCAS, Interrogator, Transponder ATCRBS, DABS, Whisper-Shout	Document is available to U.S. public through the National Technical Information Service, Springfield, Virginia 22161

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	15	

Form DOT F 1700.7 (8-72) Reproduction of completed page authorized

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

INTRODUCTION

PURPOSE.

This report describes the test bed configuration of the active mode airborne beacon collision avoidance system (BCAS). The initial configuration of BCAS is described in reference 1.

BACKGROUND.

In the test bed configuration of the Federal Aviation Administration (FAA) active BCAS, two additional features were demonstrated and evaluated; namely, the discrete address beacon system (DABS) mode of operation and the multilevel power interrogation technique referred to as "whisper-shout." These features were added to the system while maintaining the initial features, thus providing the means for a valid comparison in the identical flight environment. Reference 1 shows the initial configuration of the active BCAS.

BCAS is independent of the ground-based air traffic control (ATC) system, obtaining its information by eliciting replies from all altitude-reporting, transponder-equipped aircraft within the range of coverage. It is designed as an aircraft equipment option to provide collision avoidance system (CAS) capability in airspace where the ATC system does not provide surveillance-based separation services. In addition, the system will provide some backup to the ground system in airspace within surveillance coverage.

The active mode of BCAS operation described in this report consists of an airborne interrogator, interrogating omnidirectionally in the air traffic control radar beacon system (ATCRBS) and DABS mode. Replies are received from all aircraft within a range of approximately 32 nautical miles (nmi) equipped with altitude-reporting transponders. The replies are then sorted to obtain range and altitude and then tracked to determine whether or not they are a threat. When the BCAS threat detection and resolution logic projects a time to "range zero" of 30 seconds and altitude within ±500 feet, evasive action is displayed to the pilot.

The BCAS hardware was first assembled as two complete systems and was bench checked at the National Aviation Facilities Experimental Center (NAFEC). The two BCAS's were then installed and tested in FAA flight test aircraft.

The interim BCAS report (reference 1) covers flight tests in the NAFEC, Philadelphia, and Washington, D.C. airspace during 1976. Federal Aviation Administration report FAA-RD-80-7 covers flight tests in the Los Angeles airspace for February and May 1978 and contains all the data reduction and analysis for these flights.

Data replies from all aircraft were collected on N-47 and N-49 (NAFEC aircraft) via the BCAS. Data from all aircraft were also collected via the Los Angeles Automated Radar Terminal System (ARTS) III. All N-47 and N-49 flights consisted of head-on encounters. These encounters were accomplished using a

20-nmi figure eight, with 400-foot altitude separation, crossing over at the Los Angeles airport. BCAS data were then correlated with data from the Los Angeles ARTS III.

SYSTEM DESCRIPTION

OVERVIEW.

The BCAS functional block diagram is given in figure 1. Interrogations are transmitted sequentially via top and bottom antennas, and received replies are demodulated in the receiver and then passed to the detector/tracker. The detector/tracker determines if the received replies are from new targets, established target tracks, or simply "fruit." Tracks are formed and maintained in range and altitude. An altitude reference is provided by the aircraft's own encoding altimeter, which enables the tracker to estimate the relative altitude separation of targets.

Newly formed tracks within a 10-nmi range and established tracks whose range difference becomes 10-nmi or less are flagged by the tracker, and a determination of whether this target is BCAS equipped is made. To make this determination, an air-to-air query is made via the ATCRBS mode D or the DABS data link. If the target replies (and appears at the expected range and altitude), the tracker labels the target as BCAS equipped; otherwise, it is labeled as unequipped, since all BCAS-equipped aircraft have this air-to-air data link. Established tracks (those which have been tracked for at least 30 seconds or after four successive ungarbled reports) are passed on to the threat detector to determine if a target is a threat. Separate threat algorithms are used for BCAS-equipped and unequipped targets.

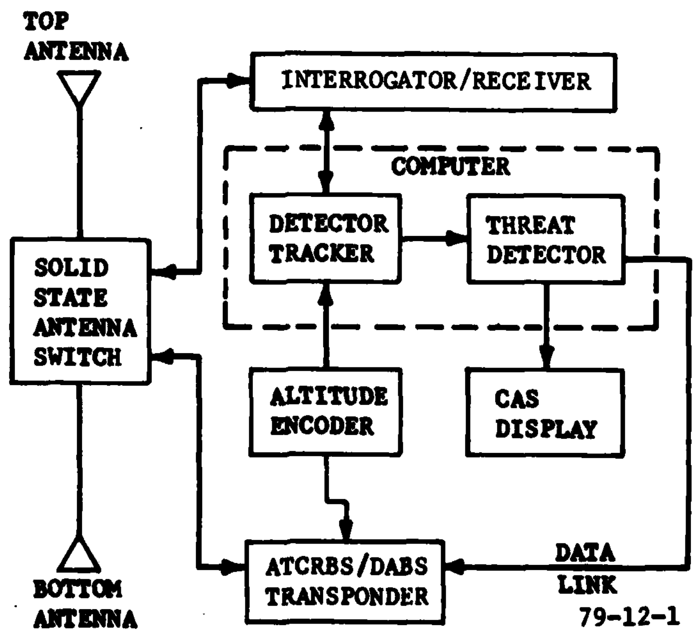


FIGURE 1. THE ACTIVE MODE BCAS BLOCK DIAGRAM

When an unequipped target is determined to be a threat, an avoidance maneuver command is displayed to the pilot of the BCAS aircraft. If, on the other hand, an equipped target is determined to be a threat, the data link is employed to assess the maneuver intent of the target. On the basis of the reply received, a command is displayed to the pilot to either maneuver or not to maneuver his aircraft. When questioned, the aircraft replies with a code that describes the command message sent to its display. This elementary data link provides the means for ensuring that aircraft make complementary maneuvers.

To minimize the interference impacts on ATCRBS and DABS ground surveillance, the rate of interrogations should be minimized. The design calls for a rate of only two interrogations per second for each mode of operation (ATCRBS/DABS). The interrogations are transmitted first from an antenna atop the aircraft and then from beneath the aircraft. This is necessary to avoid antenna shielding due to the fuselage. The appendix is the result of automatic BCAS air traffic control advisory tests.

TRANSMITTER/RECEIVER.

The transmitter/receiver used by BCAS is a standard APX-76 Air Force Identification, Friend or Foe (IFF) transmitter/receiver modified to operate in the DABS mode as well as in the ATCRBS mode. The transmitter/receiver is coupled to top and bottom antennas, with interrogations transmitted alternately via each antenna to ensure coverage above and below the aircraft. The receiver accepts the replies from surrounding aircraft, demodulates them, and provides the video to the reply detection logic. The window size for received replies is made sufficiently wide to account for pulse position uncertainty due to pulse jitter and pulse tolerance. All bracket-detected pulse pairs and their decoded binary sequences are sent to the detector/tracker.

DETECTOR/TRACKER.

There are three major functions of the detector/tracker. These functions are: track acquistion, track extension, and track elimination. To acquire or form new tracks, all replies on four successive interrogations are used. Each second reply received is connected by a straight line to all replies received on the third interrogation which could possibly relate to a given track and for which the range rate would be negative (aircraft closing on interrogator). This would mean the slope of the straight line should be negative. However, due to transponder jitter, some straight lines will be formed with slightly positive slopes. The maximum negative slope allowed is limited by the anticipated maximum closing rate of aircraft.

Once all reasonable pairs have been connected by straight lines, each line is extended backwards and projected forward in time by a one-time interval. A range window is placed at each end of the straight line corresponding to the first and fourth interrogation replies. This window accounts both for aircraft motion and for expected transponder jitter. Any replies falling into the window are considered part of a track. If more than one point falls within a window, there will be more than one track formed. If no reply falls at either end point, no track acquisition is declared.

After a new track is formed, an altitude is associated with this track by taking the altitude reports from each of the four replies associated with the track and passing them through an "AND" logic. Thus, if at least one of the reports is garble free, the correct altitude will be associated with the target.

THREAT DETECTOR.

The threat detector receives as its input the relative range, relative range rate, altitude, and altitude rate of established aircraft tracks. It determines whether a command is necessary and, if so, issues it until the conflict is resolved.

The threat detector is capable of solving conflicts with another BCAS-equipped aircraft, or with an ATCRBS mode C or a DABS mode C aircraft.

Two different detection and resolution logics are used, depending on the equipage of the intruder aircraft. If it is BCAS-equipped, the logic specified in the Air Navigation/Traffic Control (ANTC) report No. 117 (issued by the Air Transportation Association of America, June 1967) is employed; otherwise, a remitter logic is utilized which makes use of either a modified range-tau test and a vertical-tau test (when the relative range is negative or an immediate range and altitude test, when it is positive). In both logics, a maneuver command is not displayed until it appears as a result of two consecutive interrogations.

When the ANTC-117 logic determines that a command should be displayed, it interrogates via the data link to determine the maneuver intent issued by the ANTC-117 logic of the intruder aircraft. Based on the reply, a complementary collision avoidance command is displayed to the pilot.

DISPLAY.

The display is shown in figure 2. It is a standard CAS display which indicates to the pilot the following negative and positive commands:

Negative	Positive
Don't climb.	Level off.
Don't descend.	Climb.
Don't climb more than 500 feet per minute (ft/min).	Descend.
Don't climb more than 1,000 ft/min.	
Don't climb more than 2,000 ft/min.	
Don't descend more than 500 ft/min.	
Don't descend more than 1,000 ft/min.	
Don't descend more than 2,000 ft/min.	

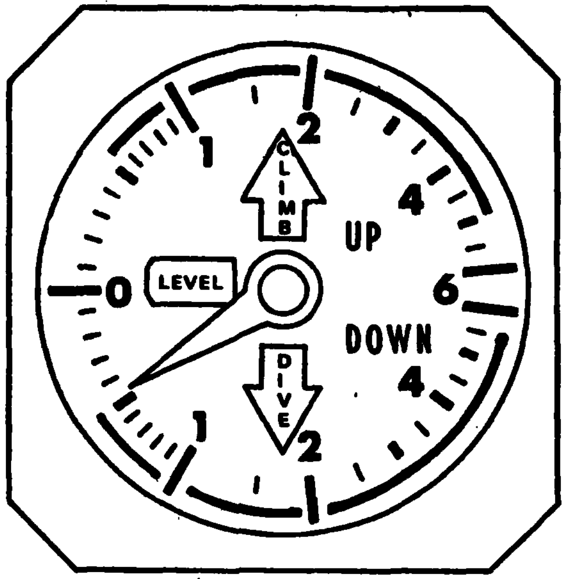


FIGURE 2. CAS DISPLAY

DATA LINK.

As indicated in preceding sections, communication between two BCAS-equipped aircraft is required to coordinate maneuvers. There are a total of four different data link messages (level off, climb, descend, or no positive command). Therefore, four data link code words are needed. The code words are chosen so that the message is decodable when up to three pulse positions are garbled. Further error protection against fruit is obtained by repeated interrogation and periodic interrogation once a threat is detected. The code word for the data link response is supplied to the transponder immediately upon determination of the maneuver, so that any aircraft making a query interrogation after that instant will be informed of the aircraft's intent.

HARDWARE PROCUREMENT.

The hardware system components used in the BCAS test bed facility were purchased, as available, or obtained from other government facilities. The interrogator receiver/transmitter employed was the Hazeltine APX-76 (RT 868A), while the transponder used in the initial ATCRBS phase of BCAS was a Bendix model TRA-63A. During the final phase, two of the DABS prototype transponders were employed. These units were manufactured by Bendix.

The solid-state (diode) antenna switch was designed and built by Microwave Associates, while the minicomputer employed was the Rolm RUGGEDNOVA model 1602 (AN-UYK-19). The time-code generator was a Datametrics SP-380. The CAS display was a modified instantaneous vertical speed indicator (IVSI) whose maneuver indicator lamps are controlled by the computer. A lamp-driver interface was designed and built at NAFEC to convert the computer-generated CAS advisories to visual indications for the pilot and observers in the back of the aircraft. The Signal Processing Interface Unit (SPIU) was the beacon data acquisiton system from the ARTS II. These units were manufactured and later modifed for BCAS by Lockheed Electronics Corporation.

HARDWARE FUNCTIONAL DESCRIPTION

OVERVIEW.

The computer software controls all hardware components of BCAS through the SPIU. The computer provides the master control signals to the SPIU defining the mode and the sequence of each of the hardware functions. The SPIU contains the interface receiver, driver amplifiers, pulse shapers, memory, and logic components required to control and communicate with each of the hardware components (figure 3).

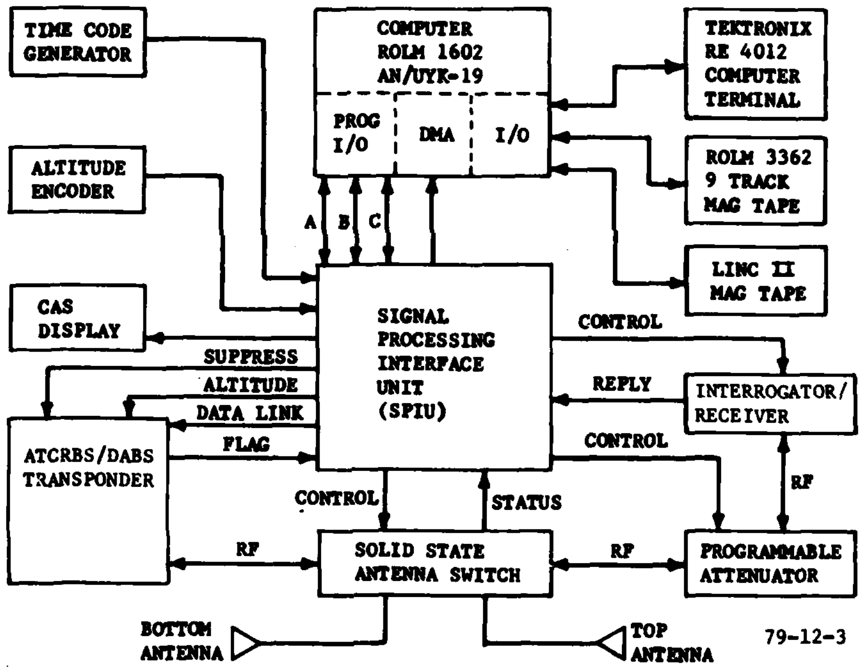


FIGURE 3. ACTIVE MODE BCAS TEST BED BLOCK DIAGRAM

SPIU CONTROL AND MONITOR FUNCTIONS.

The SPIU, upon command from the computer, controls the timing sequence, generates the interrogation pulses for the specified interrogation mode, and controls the duration of the reply period. The SPIU monitors the command signals from the computer and will not permit an invalid combination of commands (as might result from a programing error) to initiate an operational cycle. For example, the SPIU will reject the simultaneous issuance of more than one interrogation mode at a time. The SPIU will also provide a MODE VALID response to the computer if and only if the command calls for one valid interrogation mode and a suppression signal to its own BCAS transponder. The SPIU controls the solid-state antenna switch upon command from the computer and examines the status signal from the antenna switch to insure the proper status before allowing an operational cycle.

SPIU INTERFACE FUNCTIONS.

SPIU COMPUTER INTERFACE. The interface between the SPIU and the computer consists of data and control lines for the programmed data channels and from the direct memory access channel.

PROGRAMMED DATA CHANNEL INTERFACE. The programmed data channel interface consists of three sets of input data lines (A,B,C) and three sets of output data lines (A,B,C). Each of these sets contain 16 data lines to accommodate the 16-bit words from the fully buffered input/output (I/O) channels and control lines for each set of data lines.

Input channel A conveys the altitude from the encoder to the computer, along with three other signals from the SPIU, including the data link query flag, interrogate status, and interrogate complete control signals.

Input channel B conveys the least significant portion of the time word from the time-code generator.

Input channel C conveys the most significant portion of the time word.

Output channel A conveys the control command signals from the computer to perform the following functions:

1. Select the antenna (upper or lower).
2. Suppress the BCAS transponder.
3. Initiate and control the interrogation mode.
4. Initiate and control the transmit cycle.

Output channel B conveys the data link reply to the system transponder via the SPIU and a control signal to reset the data link query flip-flop.

Output channel C conveys the control signals to the CAS display interface to drive the selected CAS display warning or command lights.

DIRECT MEMORY ACCESS CHANNEL INTERFACE. The direct memory access channel interface consists of 16 data lines and the necessary control lines. The direct memory access data lines convey the 12-bit data word recovered from the reply and its associated 12-bit range words.

SPIU-TRANSPONDER INTERFACE. The SPIU-transponder interface consists of:

1. A suppress line to provide a 25-volt pulse to suppress the transponder during the interrogation cycle.

2. A data link query flag line to inform the computer of a query interrogation detected by the transponder.

3. Twelve data lines to convey the data link reply from the computer to the transponder.

SPIU-INTERROGATOR INTERFACE. The SPIU-interrogator interface consists of two coaxial lines: one to convey the interrogation video pulse pairs from the SPIU to the interrogator, and the second line to convey the serial video of the reply to the SPIU.

SPIU-ALTITUDE ENCODER INTERFACE. The SPIU-altitude encoder interface consists of dual serial inverters in each of the 10 altitude encoder lines, which provides an open-bit line for a "0" and a grounded bit line for a "1." The altitude signals are thus buffered by the inverters. The first inverter provides the correct signal polarity for the programmed data channel, and the second inverter returns the signal to the polarity required by the transponder.

SPIU-TIME CODE GENERATOR INTERFACE. The SPIU-time code generator interface is made up of a Schmitt trigger followed by an inverter in each of the 24 time-bit lines. The reason for this circuit configuration is to provide reliable operation in view of the fact that the time-code generators do not have adequate line drive capability.

SPIU-ANTENNA SWITCH INTERFACE. The SPIU-antenna switch interface consists of two pairs of differential driver lines and two pairs of differential receiver lines. The driver lines control the antenna switch, and the receiver lines report the status of the antenna switch to the computer through the SPIU. The power for the antenna switch (+12 volt and -12 volt direct current (d.c.)) is provided by the SPIU by way of the interface.

SPIU-CAS DISPLAY INTERFACE. The SPIU-CAS Display Interface consists of 12 dual lamp-driver amplifiers. Each lamp-driver amplifier functions, as commanded by the computer, to illuminate the specified warning or command lamps of the two CAS displays. One CAS display is in the cockpit and one is on the BCAS equipment rack.

WHISPER-SHOUT FEATURE.

The multipower-level interrogation feature, normally called "whisper-shout," is a technique to distribute the population of beacon replies into a number of smaller categories, as determined by the ascending interrogation power levels. Transponder/receiver sensitivity is also a factor in determining the category into which the transponder reply will fall. The whisper-shout concept was intended to distribute the workload on the processor and offer, in addition, the possibility of separating garbled replies due to differences in transponder/receiver sensitivity.

The whisper-shout interrogation sequence begins with a minimum power interrogation. After allowing 500 microseconds (μs) for all replies to be received, a suppression pulse pair was transmitted, 1.5 decibles (dB) lower in power than the previous interrogation. This was done to prevent the response of the transponders which have just replied to the previous level. An interrogation was then made at the next higher power level, and the sequence was repeated through the eight levels, each level being suppressed at a slightly lower power level. The reason for the suppression at the lower power level was to prevent the loss of replies from transponders whose sensitivity was on or near the boundaries of the power levels. It would be better to have the reply fall into two adjacent level bins than to miss the reply. The operational program and SPIU logic were both modified to accommodate the whisper-shout feature and the DABS mode of operation in addition to the normal mode. The whisper-shout attenuator provides attenuation from 0 - 31dB in 1-dB steps and is selected by the computer program. One set of values used is as follows: 0dB - 6dB - 10dB - 12dB - 14dB - 16dB - 18dB and 20dB.

PERFORMANCE AND HARDWARE MODIFICATIONS

INTERROGATOR RECEIVER PERFORMANCE.

The theoretical considerations regarding the ability of BCAS to track aircraft through garble situations was based on the reply code "1's" being relatively indestructible, and reply "0's" being subject to alteration when replies from several aircraft overlap.

Observation of the data contained in the raw radar buffers, as recorded on the BCAS magnetic tape, indicated that information was lost when two or more replies overlapped. The two remote aircraft may be widely separated, but approximately equidistant from the BCAS-equipped aircraft; thus, the replies overlap and distort their data content. As expected, a reply could superimpose its 1's over the other reply's 0's, but the video processing circuitry caused something unexpected to happen. When the 1's from the two replies were superimposed, the 1's were destroyed. Analysis of the performance of the interrogator video processor circuit revealed that the pulses did not add, as expected, when the two video signals merged. Instead of adding as the pulses started to overlap, the pulses split into two, and finally into three narrow pulses, which would be rejected by the pulse-width discriminator in the data acquisition portion of the SPIU resulting in the loss of information and subsequent discontinuities in the tracking of the garbled replies. This problem was observed primarily in the analysis of the data collected on magnetic tapes in the Washington, D.C. area, where there are a considerable number of ground-based interrogators and a moderate air traffic density.

INTERROGATOR CORRECTIVE MODIFICATIONS.

The circuit correction to prevent the loss of reply code 1's in a garble environment was accomplished by simply bypassing the portion of the video processor circuit that caused the pulse splitting. The only portion of the video processor circuit used was the two-stage input driver amplifier coupled directly to the output emitter follower amplifier. The receiver video was thus passed on to the SPIU as analog video. The receiver video which was previously standardized digital pulses, was now analog sigals with amplitude inversely related to the range. This modification corrected the data loss problem in the interrogator, but the resulting signal amplitude and baseline level changes required some modification of the beacon video quantizer circuit board of the SPIU.

INTERROGATOR MODIFICATIONS FOR DABS CAPABILITY.

Modifications were made to the APX-76 (RT 868A) receiver transmitter by Hazeltine Corporation to provide the capability for transmission of the DABS differential phase shift keying (DPSK) mode as well as the normal ATCRBS pulse amplitude modulation mode interrogation. This modification resulted in rerouting several internal coaxial connections within the RT 868A unit and making one front-panel radiofrequency (RF) connector available for the dual-mode operation. The dual-mode function was provided by an auxiliary box, approximately the size of the RT 868A unit; the two units were connected by two coaxial cables.

SPIU MODIFICATIONS FOR DABS CAPABILITY.

Modifications were made to the SPIU to accommodate and control the added DABS functions, data formats, and the DABS interrogation control logic.

SPIU MODIFICATIONS FOR WHISPER-SHOUT.

The varied power levels were controlled by a computer-controlled RF attenuator. A seven-bit word from the operational program was stored in a register in the SPIU and controlled the RF attenuator. A word of seven 0's provided minimum attenuation (less than 1 dB), while a word of seven 1's provided the maximum attenuation of approximately 31 dB. The SPIU was modified by adding the register to hold the seven-bit word and applying the control word to the RF attenuator. Additional logic was added to control the interrogation and suppression sequence through the eight levels.

SPIU BEACON VIDEO QUANTIZER (BVQ) MODIFICATIONS.

Several modifications were made to the BVQ circuit board to achieve compatibility with the interrogator modification and to generally improve the performance of the quantizer.

A multiturn potentiometer formerly used to adjust the amplitude of test video (presently not required) was reconnected to function as an input signal level threshold control. This control provided the means to properly match the signal level of the receiver video from the interrogator.

A new multiturn potentiometer was added to the input of the amplifier preceding the peak detector. The original detector circuit was designed to detect at approxmiately the 50-percent amplitude level. The addition of the new control potentiometer and several resistor value changes provided the means to adjust the video pulse amplitude detection to approximately 120 millivolts below peak amplitude. The change was required since the receiver video pulses from the interrogator are no longer standardized 5-volt pulses (Interrogator Corrective Modifications).

To further insure the stability of the various input thresholds, signal peak and threshold detectors, the three potentiometer circuits are now regulated by zener diodes.

The peak detector was originally reset from the output of the voltage comparator. The circuit performance was improved by resetting the peak detector with the output of the signal threshold detector.

Another minor circuit modification was made which has no effect on the circuit performance; its purpose was to allow the circuit to operate under test without an enable signal from the computer. The input enable gate, which originally controlled the input beacon video, was reconnected to control the output of the beacon video quantizer.

SPIU PARALLEL BRACKET DETECTOR MODIFICATIONS.

The following paragraphs describe the corrective action taken to modify the parallel bracket detector problem.

OVERVIEW OF THE PROBLEM. The analysis of some of the data collected on magnetic tape indicated occasional loss of reply-1 bits in a garble-free environment. Although this condition occurred very infrequently, it deserved attention. Transponder pulse spacing or pulse-width maladjustment was suspected as a possible explanation of this loss of information. The bracket detector is a 208-bit shift register from which the 12 bits of the reply are extracted from their respective pulse position taps. Observation of the bracket detector in operation indicated that the presently used taps were the optimum design choice for most transponders.

CORECTIVE MODIFICATIONS OF THE PARALLEL BRACKET DETECTOR. Each stage of the 208-bit shift register represents approximately 120 nanoseconds (ns); therefore, the 450-ns reply pulse would be contained in three or possibly four stages. The center stage for each pulse was chosen and appears to be optimum for most transponders, as mentioned in the Overview.

To accommodate the transponders with the "out of tolerance" pulse spacing, the logic was modified to detect the pulse in the stage following, as well as the original stage. This was accomplished by adding 12 "OR" gates, one for each of the 12-reply code taps, each gate having two inputs, the original tap and the one following (later in time). This modification appeared to correct the rarely encountered data loss due to suspect transponders.

SPIU ALTITUDE ENCODER PROBLEM AND MODIFICATIONS.

The following paragraphs outline the modifications to the SPIU in order to prevent erroneous altitude reports.

OVERVIEW OF THE PROBLEM. The aircraft pressure altitude encoder signal bus provides input to the SPIU-altitude interface as described in SPIU-altitude encoder interface, as well as the normal connection to the aircraft transponders. During a BCAS test flight, the normal aircraft transponder is turned off, and the BCAS transponder becomes the aircraft transponder. During other aircraft flights when the BCAS was not in use, although still connected to the altitude encoder bus, erroneous altitude was being reported by the aircraft transponder. This erroneous altitude is caused by loading effect of the SPIU interface circuits on the altitude encoder bus with the SPIU in POWER OFF status.

CORRECTIVE MODIFICATION OF ALTITUDE ENCODER INTERFACE. A simple solution to this problem was to remove the altimeter cable connector from the rear of the SPIU at the conclusion of the BCAS operation.

REFERENCE

1. Cohen, M. and Richardson, C., Beacon Collision Avoidance System (BCAS)-Active Mode, DOT/FAA, Report No. FAA-RD-77-98, October 1977.

APPENDIX

BCAS AIR TRAFFIC CONTROL ADVISORY

A technique to inform the air traffic control system of BCAS-suggested maneuvers was proposed during the flight test phase of the active mode BCAS. The proposed method consisted of substituting special codes in place of the normal 3A (identity) code for duration of a BCAS "climb" or "dive" command. The special codes chosen for the experiment were 7400 for a dive command and 7500 for climb command. The CAS display interface module was modified by adding the logic elements to provide the code substitution.

A feasibility test was conducted in July 1976. For the purpose of this test, the ARTS III operation program in the NAFEC Terminal Air Traffic Facility was modified via the controller keyboard. The program change interpreted a 7400 (dive) code as if it were a 7600 (radio failure) code, and the 7500 (climb) code was interpreted as a 7700 (emergency) code. These codes normally will blink on the controller's display.

The tests of this feature were conducted during one of the normal BCAS flight tests involving two aircraft crossing with 400-foot altitude separation. Several such encounters were conducted with the test aircraft above and several with the test aircraft below. Each encounter produced a "climb" or a "dive" indication on the CAS display and the corresponding warnings of "Emergency" or "Radio Failure" on the controller's display. Having demonstrated the feasibility of this technique, the tests were terminated upon completion of this flight.

DATE

ILMED

-8